



## **MANAGEMENT OF WATER RESOURCES THROUGH RESOURCES DIVERSIFICATION IN AN ARID REGION: CASE STUDY FROM ABU DHABI EMIRATE, UNITED ARAB EMIRATES (UAE)**

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### **ABSTRACT**

Abu Dhabi Emirate is situated in one of the most stressed area in water resources in the world. Water resources in Abu Dhabi Emirate, which is located to the west and southeast of the United Arab Emirates (UAE), is very scarce as the area is mainly characterized by low amount of rainfall and high rate of evaporation and temperature. Previously, groundwater was the principal source of water for human uses, however, with the time; desalinated water became the main source of life in the Emirate. Groundwater resources in the Emirate are limited source as it depends mainly on the rainfall recharge. It is observed the average annual withdrawal of groundwater is reducing with the time, where it reduced by 22.5% during the period of 2005-2011. In addition, it is noted that regulation enforcement accompanied with long-term vision to sustain the water resources in the Emirate lead to such reduction. The Government of Abu Dhabi Emirate made significant efforts to secure the water resources through sources diversification. Such measurement helps the decision makers in the Emirate to secure the water resources for future generations. In order for better management, it is essential to assess the water resources in the Emirate in regular basis.

**Keywords:** Abu Dhabi Emirate, Groundwater, Water Resources, United Arab Emirates

### **1 INTRODUCTION**

Abu Dhabi Emirate is situated in one of the most stressed area in water resources in the world. Water resources in Abu Dhabi Emirate, which is located to the west and southeast of the United Arab Emirates (UAE) (Fig. 1), is very scarce as the area is mainly characterized by low amount of rainfall and high rate of evaporation and temperature. The temperature in Abu Dhabi Emirate varies seasonally and it ranges from 17.5 °C, which recorded in December in Al Ain area, to 37°C, which recorded in the western region in August. Rainfall in Abu Dhabi Emirate is scanty and it averages from 23.2 mm in 2010 to 21.5 mm in 2011, which is beyond the average rainfall of the whole UAE. This paper is aimed to address water resources diversification of Abu Dhabi Emirate as the largest emirate in whole UAE.

### **2 WATER RESOURCES ASSESSMENT**

Assessment of water resources in most stressed area is essential for water security. Continuous assessment for water resources of the area will help the decision makers to sustain the natural resources for future generations. There are conventional and non-conventional water resources in Abu Dhabi Emirate and those resources are groundwater, desalinated water and treated wastewater. Previously, groundwater was the principal source of water for human uses, however, with the time; desalinated water became the main source of life in the Emirate.

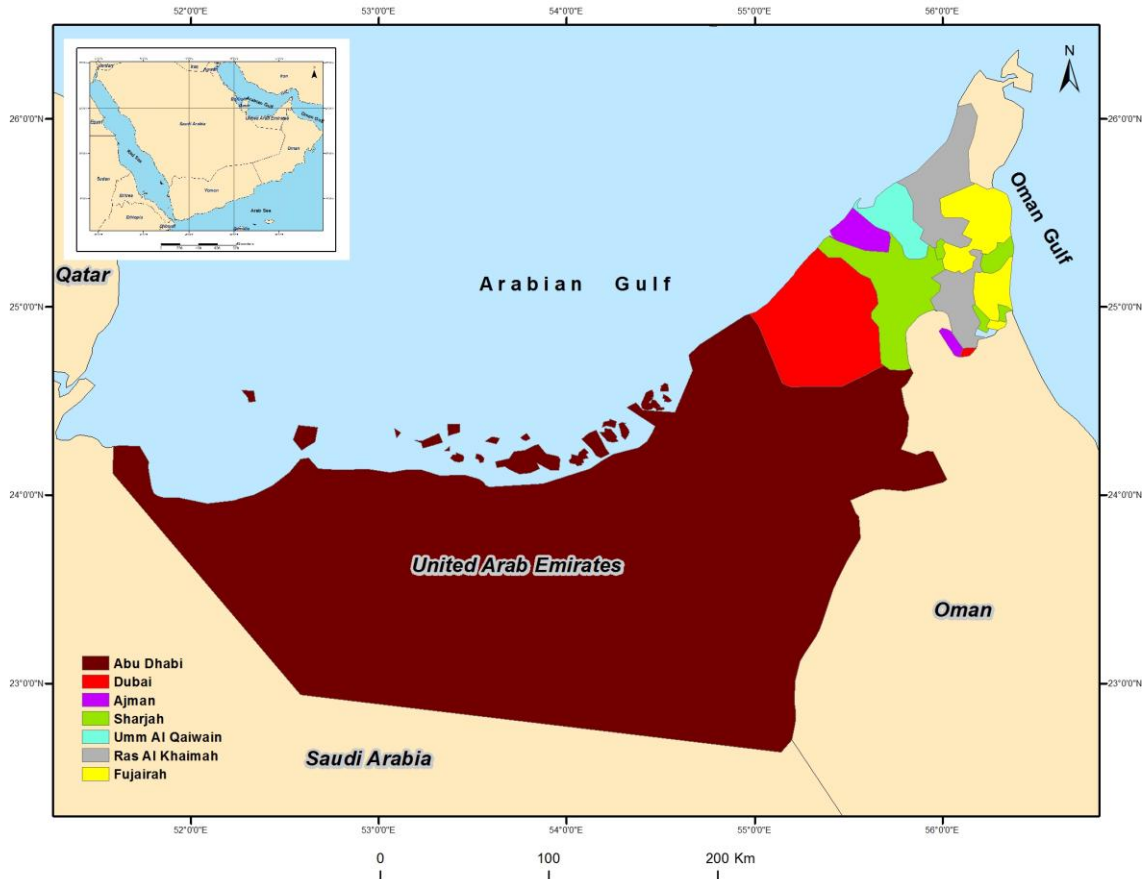


Figure 1. Location of the UAE relative to Arabian Peninsula.

## 2.1 Groundwater Resources

Groundwater resources in the Emirate are limited source as it depends mainly on the rainfall recharge. Based on the geology of the major aquifers in the UAE, about 10% of rainfall recharged the aquifer. In Abu Dhabi Emirate, the total number of working groundwater wells was 71,165 wells in 2011 in comparison with 68,200 wells in 2010. Out of that, about 47% of total working wells in Abu Emirate existed in Al Ain region and about 40% and 13% of these wells in 2011 existed in western region and Abu Dhabi city respectively. In addition to that, there were 22,195 groundwater wells not operating in whole Abu Dhabi Emirate. The distribution percentage of groundwater wells reveals that majority of groundwater wells are in Al Ain region followed by western region of Abu Dhabi Emirate then Abu Dhabi city. The high percentage of groundwater wells in Al Ain region may be related to the fact that the agricultural practices are the main land use in the area, which could be linked to the quality of groundwater in the area comparing with other parts of the Emirate. The average groundwater withdrawal in Abu Dhabi Emirate in 2011 is 2,217.9 MCM comparing with 2,862.1 MCM in 2005 (Environment Agency – Abu Dhabi, 2014) (Fig. 2). It is observed the average annual withdrawal of groundwater is reducing with the time, where it reduced by 22.5% during the period of 2005-2011. Also, it is noted that regulation enforcement accompanied with long-term vision to sustain the water resources in the Emirate lead to such reduction. As a consequence of groundwater deterioration and withdrawal, groundwater reserves in the Emirate reduced by 1.7% during the period of 2005-2011, and it reduced from 646,750 MCM in 2005 to 635,620 MCM. Available data showed that about 79% of groundwater reserves are saline and only 3% of available groundwater is fresh.

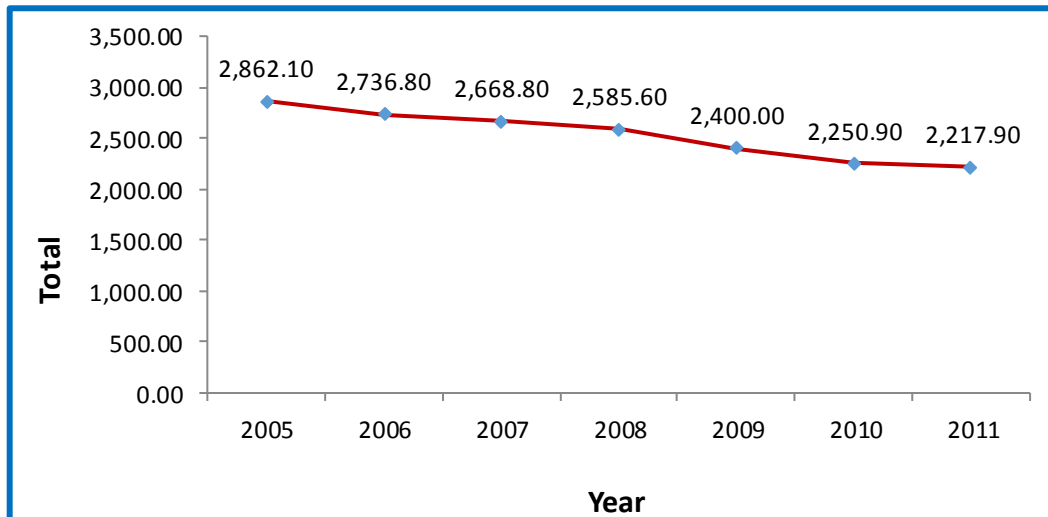


Figure 2. Average groundwater withdrawals (MCM) in Abu Dhabi Emirate from 2005 -2011 (source of data: Environmental Statistics 2011, Statistics Centre – Abu Dhabi, October 2012).

## 2.2 Desalinated Water

At the present, Abu Dhabi Emirate relies on desalinated water as the main source of water. Production of desalinated water in the Emirate is managed and maintained by Abu Dhabi Water & Electricity Authority (ADWEA). The production of desalinated water in the Emirate in 2011 increased by 3.8% and reached 999.2 million cubic meter (MCM) compared with 962.3 MC in 2010 (Ministry of Energy, 2014 & Abu Dhabi Statistics Centre, 2012) (Fig. 3).

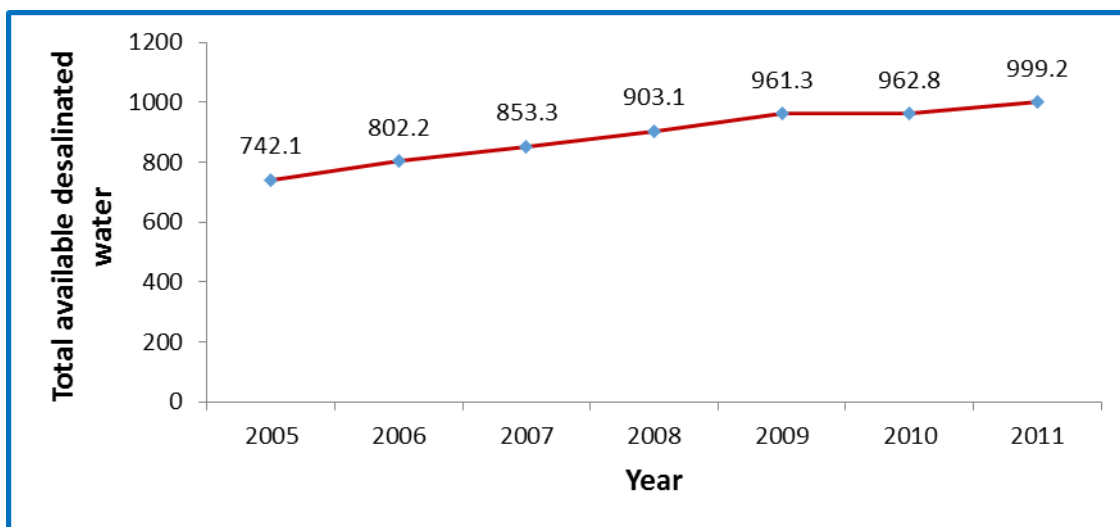
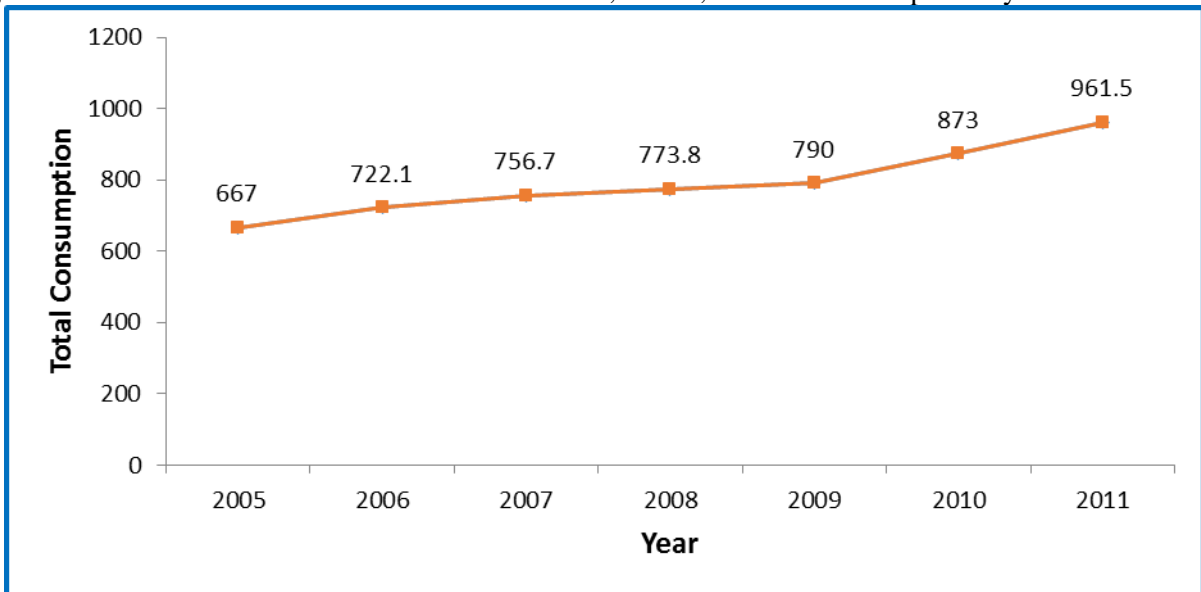


Figure 3. Total available desalinated water (MCM) in Abu Dhabi Emirate from 2005 -2011 (source of data: Environmental Statistics 2011, Statistics Centre – Abu Dhabi, October 2012).

The total consumption of desalinated water in 2011 was 961.5 MCM comparing with 873 MCM in 2010. It is clearly shown that both consumption and production are increasing with time and this might be ascribed to economic development and population growth. Political stability of the UAE also lead to increase the migration, which increased the consumption of water. On the other hand, the daily average per capita in Abu Dhabi Emirate was 1.4 and 1.2 m<sup>3</sup> in 2006 and 2011 respectively. It is clear that the daily average per capita is decreased and this could be related to successful awareness campaigns by different concerned environmental authorities in the Emirate. Total consumption of desalination water increased from 667 MCM in 2005 to 961.5 MCM in 2011 (Fig. 4). However, the consumption of desalinated water in Abu Dhabi region increased from 529 MCM in 2010 to 592.6 in



2011 and this consumption account for about 62% of total consumption of all Abu Dhabi Emirate. The domestic sector consumed about 54.3% (522.2 MCM) in 2011 of the total consumption of all sectors in the Emirate. However, the consumption of desalinated water for government, commercial, agriculture and industrial sectors accounted for 22.2%, 15.7%, 3.2 and 1.9% respectively.

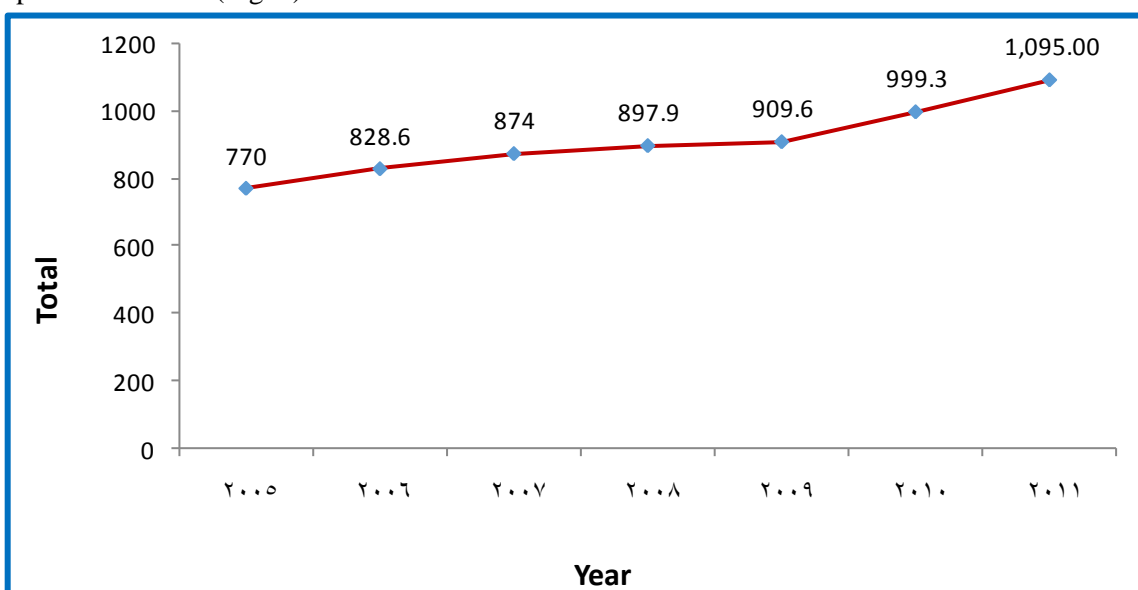


**Figure 4. Total consumption of desalinated water in Abu Dhabi Emirate from 2005 -2011 (source of data: Environmental Statistics 2011, Statistics Centre – Abu Dhabi, October 2012).**

### 2.3 Treated Wastewater

Treated wastewater is another source of non-conventional water resources and is increasing to meet the demand. The total production of treated wastewater increased from 148.3 MCM in 2005 to 243.1 MCM in 2011. However, the total quantity of treated wastewater reuse increased from 103 MCM in 2005 to 133.5 MCM in 2011 (Abu Dhabi Statistics Center, 2012). Statistics data showed that treated wastewater is emerging source for water resources in Abu Dhabi Emirate.

Generally, non-conventional water resources in the Emirate including both desalinated water and treated wastewater increased from 770 MCM in 2005 to 1095 MCM in 2011 with an increase of 9.6% compared with 2010 (Fig. 5).



**Figure 5. Total non-conventional water resources in Abu Dhabi Emirate from 2005 -2011 (source of data: Environmental Statistics 2011, Statistics Centre – Abu Dhabi, October 2012).**



### 3 WATER RESOURCES UTILIZATION

The main utilization for water resources in Abu Dhabi Emirate is agriculture sector, where the total consumption of water for this sector decreased from 2,736.2 MCM in 2008 to 2,382.1 MCM in 2011 (Fig. 6). Provided data indicates that the groundwater consumption for irrigation was decreased from 2,585.9 MCM in 2008 to 2,217.9 MCM in 2011. However, the reuse of treated wastewater for irrigation increased from 124.1 MCM in 2008 to 133.5 MCM in 2011. Generally, it is observed that the total consumption of different resources of water decreased during the period of 2008-2011, where the total cultivated area increased slightly changed from 235,169.1 hectare in 2008 to 235,235 hectare in 2011 (Abu Dhabi Statistics Centre, 2012).

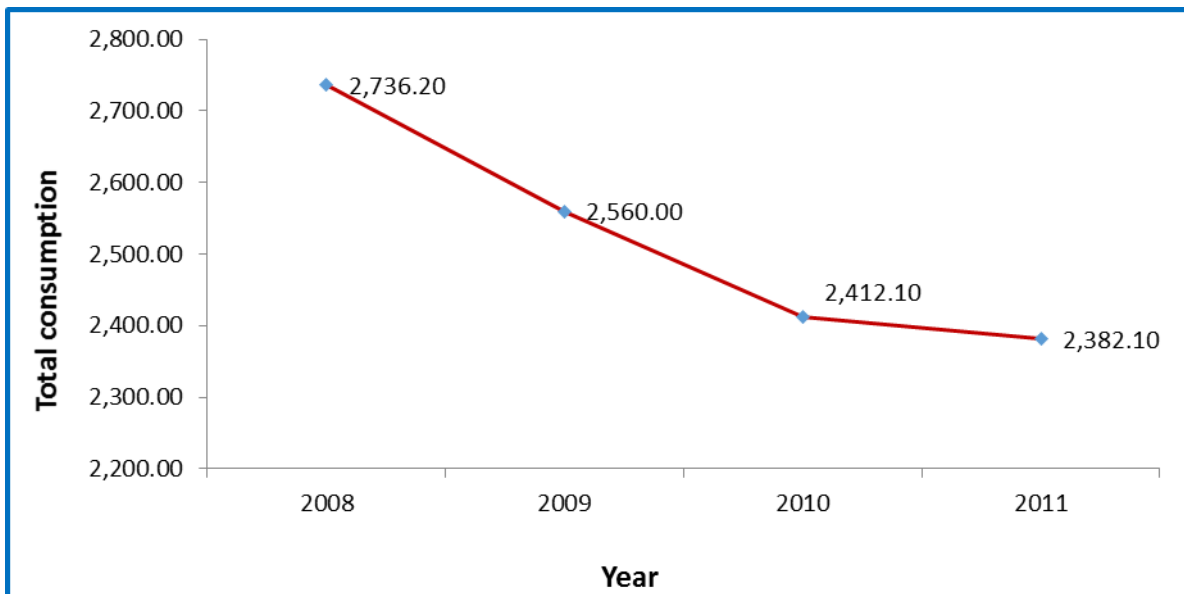


Figure 6. Total consumption of water for irrigation practices in Abu Dhabi Emirate from 2005 -2011 (source of data: Environmental Statistics 2011, Statistics Centre – Abu Dhabi, October 2012).

### 4 CONCLUSIONS

This assessment for the water resources in Abu Dhabi Emirate showed that the non-conventional water resources including desalinated water and treated wastewater are main sources of water. Conventional water resources including groundwater is deteriorated significantly in the Emirate due to heavy pumping of groundwater for agricultural practices and aridity of the region which characterized by low amount of rainfall and high rate of evaporation. The Government of Abu Dhabi Emirate made significant efforts to secure the water resources through different approaches such as intensive awareness campaigns, regulation enforcement and sources diversification. Such measurements help the decision makers in the Emirate to secure the water resources for future generations. In order for better management, it is essential to assess the water resources in the Emirate in regular basis.

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